1967

Effects of Continuous Running as Compared to Interval Running on Cardiorespiratory Efficiency of Conditioned Freshman Wrestlers at South Dakota State University

Terry J. Linander

EFFECTS OF CONTINUOUS RUNNING AS COMPARED TO INTERVAL RUNNING ON CARDIORESPIRATORY EFFICIENCY OF CONDITIONED FRESHMAN WRESTLERS AT SOUTH DAKOTA STATE UNIVERSITY

BY

TERRY J. LINANDER

A thesis submitted
in partial fulfillment of the requirements for the
degree Master of Science, Major in
Physical Education, South Dakota
State University

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This thesis is approved as a creditable and independent investigation by a candidate for the degree, Master of Science, and is acceptable as meeting the thesis requirements for this degree, but without implying that the conclusions reached by the candidate are necessarily the conclusions of the major department.

Thesis Adviser

Head, Physical Education Department

EFFECTS OF CONTINUOUS RUNNING AS COMPARED TO INTERVAL RUNNING ON CARDIORESPIRATORY EFFICIENCY OF CONDITIONED FRESHMAN WRESTLERS AT SOUTH DAKOTA STATE UNIVERSITY

Abstract

TERRY J. LINANDER

Under the supervision of Associate Professor Glenn E. Robinson

The purpose of this investigation was to determine whether a running program significantly influences the cardiorespiratory efficiency of conditioned wrestlers and to compare continuous running and interval running as methods of increasing the cardiorespiratory efficiency of conditioned wrestlers.

Eighteen of the 19 members of the freshman wrestling squad at South Dakota State University, Spring Semester 1967, volunteered as subjects. The 18 subjects were divided into three equated groups, the results of a cardiorespiratory efficiency test being used as the equating factor. By employing the track pillbox method, the three equated groups were designated as the Interval Running Group (IR), and Continuous Running Group (CR), or the Control Group. All three groups attended wrestling practice, but the two experimental groups supplemented wrestling practice with a running program. Group IR ran intervals of 240 yards each in a time of 40 seconds with a maximum rest between intervals of 1 minute and 30 seconds. The intervals were increased from 4 intervals per day to 7 intervals per day over the 24 day training program. Group CR ran continuously without a definite set pace for 7 minutes per day at the beginning of the program and increased to 15 minutes of continuous running

per day by the end of the program. The control group attended their regular physical education classes while the two experimental groups were exempt.

All subjects in the three groups were tested at the beginning, at approximately the mid-point, and at the completion of the training program. Oxygen consumption and pulse rate at rest and in recovery from a standardized treadmill run were used as criteria to determine cardiorespiratory efficiency.

The analysis of variance was applied to the data collected during the testing and was used to find variance between the group means and within the group means.

Duncan's New Multiple-Range Test was applied to the data that indicated or approached statistical significance in the analysis of variance test.

The results of the findings indicated that a running program in addition to wrestling practice does not appear to increase significantly the cardiorespiratory efficiency of conditioned wrestlers; and the benefits of such a program seem to be largely psychological.

ACKNOWLEDGEMENTS

The author wishes to express his sincere appreciation to Associate Professor Glenn E. Robinson and Mr. William Fritz for their assistance throughout the course of the work reported here and the preparation of this thesis.

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TABLE OF CONTENTS

TABLE OF TABLES

TABLE OF FIGURES

Chapter I

INTRODUCTION

Justification of Study

Wrestling as a sport is not only demanding physically during the season's schedule of dual meets, but becomes even more physically demanding in tournaments. In tournament competition a wrestler may have to compete in two or even three matches in a single day. The physical condition of a wrestler may determine the place he wins in a tournament or whether he places at all. Therefore, wrestling coaches are interested in improving cardiorespiratory efficiency of their wrestlers prior to the tournament series. To increase cardiorespiratory efficiency, many coaches conduct running programs in addition to the regular wrestling practice for at least two weeks prior to the tournaments. Wrestling News[1] relates how Tom Evans, the head wrestling coach at Oklahoma University, successfully applied such a running program in 1964.

[1]Wrestling News, IX, (April 22, 1964), p. 8.

> The Oklahomans were ignored in pre-tournament predictions. They had started the season without a single letterman from their NCAA championship team of 1963 and had been shoved down to fourth place in the 1964 Big Eight tournament, after losing six of their last eight dual meets. There was no basis for judging them capable of making a ripple in the national picture.
>
> "Our first decision," explains Evans, "was to prepare ourselves physically. Mental conditioning can

> be based on physical condition, so we decided our first goal would be better physical condition than any other team in the nationals."
>
> The running program was employed two weeks prior to the NCAA. "The boys hated it," said Evans, "but it finally sold them on the fact that they were in fantastic physical shape, and this made it possible to prepare them mentally."
>
> "I had told them that the other teams might own the first six minutes of each bout, but that the last three minutes belonged to us. That because of our superior conditioning, nobody should be able to stay with us if we carried it to them.... They won several bouts in the last few minutes, even seconds. They won all four over-time bouts and finished second in the NCAA."

The running program as applied by Tom Evans proved to be very effective for Oklahoma University. However, it is hard to evaluate the actual physiological effects derived due to the psychological aspects involved in the program. Evans himself stressed the psychological significance of his running program. Coach Evans convinced his wrestling team that they would be in far better condition than other teams, and he stressed that conditioning would be the deciding factor in many of the crucial matches.

The researcher must ask himself to what extent the running program increased the cardiorespiratory efficiency of the already well-conditioned squad. Was the success of the squad dependent on the physiological improvement of condition, or was the program's main contribution psychological in nature? If a wrestling coach wishes to effectively employ such a running program, it would behoove him to know what aspect should be emphasized. If a running program does not significantly increase the cardiorespiratory

efficiency of conditioned wrestlers, then perhaps the psychological implications are all-important. If such is true, the running program should be slanted toward the psychological aspects and programmed to convince the team of its excellent condition. However, if a running program does significantly influence cardiorespiratory efficiency of conditioned wrestlers, there is a need to determine what type of running program would best accomplish this purpose.

The writer became interested in this area through his participation in wrestling and through listening to discussions by coaches and wrestlers concerning the worth of a running program in addition to wrestling practice. Through the writer's own personal experience, he has found that most wrestling coaches employ a continuous running program, whereas an interval running program is used to a lesser degree. It is the writer's interest in this area that has led him to compare the effects of a continuous running program and an interval running program on a conditioned wrestling squad.

Statement of Problem

The purpose of this study was to determine whether a running program significantly influences the cardiorespiratory efficiency of conditioned wrestlers and to compare continuous running and interval running as methods of increasing the cardiorespiratory efficiency of conditioned wrestlers.

Background for Study

A search of the literature failed to reveal research directly concerned with the effects of a running program on a conditioned wrestling squad. The writer has included in this chapter literature concerning the importance of conditioning for wrestling and studies conducted on conditioning programs for wrestlers.

Rasch and Kroll[2] state that almost every textbook or article written about wrestling cites the need for wrestlers to possess outstanding levels of fitness.

[2]Philip J. Rasch and Walter Kroll, What Research Tells the Coach About Wrestling, p. 35.

Wrestling News[3] reported the lack of sufficient time to select, train, and condition the teams as one of the three reasons for the poor showing of the United States wrestlers at the World's Championships at Toledo in 1962.

[3]Wrestling News, VII, (July 11, 1962), p. 2.

Sparks[4] writes, "To wrestle efficiently and effectively requires superb physical and mental conditioning. No sport places a greater demand on over-all body strength, flexibility, and stamina than does wrestling."

[4]Raymond E. Sparks, "Conditioning for Effective Wrestling," Journal of Health, Physical Education and Recreation, December, 1955, p. 42.

Dratz, Johnson, and McCann[5] state in their book:

[5]John P. Dratz, Manly Johnson, Terry McCann, Winning Wrestling, preface, p. vi.

> . . . training and conditioning are the beginning and end of preparation for any championship competition, particularly wrestling. . . . knowing all the holds in the book won't do any good if you can't go the nine minutes at full speed.

Wrestling News[6] recounts the training program used by

[6]Wrestling News, op. cit. (April 22, 1964), p. 8.

Oklahoma University, which illustrates the importance of top physical condition in wrestling.

> For two weeks before leaving for Cornell University and the NCAA, the Sooners ran three miles of windsprints-sprint 100 yards, jog 50- every morning before breakfast. This was in addition to their regular daily practice workouts.
>
> The Oklahomans, who were ignored in pre-tournament predictions, placed second in the NCAA, winning several crucial matches in the last minutes or seconds. The Oklahomans won all four of their over-time bouts.

Yet for all the material written concerning the importance of the fitness of wrestlers, little research has been reported as to the effectiveness of select wrestling training programs.

Rasch and Kroll[7] stress, "There are two major factors

[7]Philip J. Rasch, Walter Kroll, op. cit., p. 13.

which comprise the general quality known as physical fitness: muscular strength and cardiorespiratory efficiency."

A few studies dealt with conditioning programs designed to improve the muscular strength of wrestlers. Berndt,[8] Johnson,[9] and Caro,[10] showed an interest in this area. A search of the literature revealed only one study that related to improving the cardiorespiratory efficiency of wrestlers. Vohaska[11] conducted a study to determine the importance of a dietary supplement on the cardiorespiratory efficiency of wrestlers.

[8]Donald Wilham Berndt, "A Comparative Study of Conditioning Programs for Use in Amateur Wrestling," (M. S. Thesis, Springfield College, 1955).

[9]Neil Ralph Johnson, "The Effectiveness of Wrestling Compared to Standard Weight Training Procedures for the Development of Strength," (M. S. Thesis, Pennsylvania State University, 1960).

[10]Fred J. Caro, "Conditioning Effects of Two Wrestling Drills," (M. S. Thesis, Springfield College, 1964).

[11]William J. Vohaska, "The Effects of Wheat Germ Oil on the Cardiovascular Fitness of Varsity Wrestlers," (M. S. Thesis, University of Illinois, 1954).

Summary

A review of the literature showed there has been little research conducted on wrestling conditioning programs designed to improve strength; however, the writer was unable to find any research concerning wrestling conditioning programs designed to improve cardiorespiratory efficiency.

Limitations of Study

1. This study was limited to 18 wrestlers of the South Dakota State University freshman squad.
2. The eating and drinking habits of the wrestlers were controlled temporarily for weight reduction in preparation for competition.
3. No effort was made to motivate participants in the study.
4. The interval running program was conducted on the gymnasium floor.
5. The continuous running program was conducted in the wrestling room.

Definitions

1. Interval Running: Training over a timed set distance and including a number of fast runs interspersed with a recovery interval. The controlled factors in interval running were: (1) the distance of the run (2) the speed of running (3) the amount of rest between intervals, and (4) the number of repetitions.
2. Continuous Running: As accepted for this study, running without rest until the required time limit for the run had elapsed.
3. Cardiorespiratory Efficiency: The ability to sustain a long continued physical activity.

Chapter II

PROCEDURE FOR OBTAINING DATA

Introduction

The subjects used in the study, the oxygen consumption test, the pulse rate test, and the training programs employed are described in this chapter.

Subjects

Subjects for the investigation were members of the freshman wrestling squad at South Dakota State University, Spring Semester, 1967. Eighteen of the 19 members of the freshman squad volunteered to be subjects for the investigation.

To maintain greater control over the activity of the subjects and due to the strenuous nature of the experiment, the subjects in the experimental groups were exempted from their basic physical education activity class. No physical examination was required as the subjects had received an examination prior to the pre-season wrestling practice sessions.

The 18 subjects were divided into three equated groups, the results of a cardiorespiratory efficiency test being used as the equating factor. By employing the track pillbox method, the three equated groups were designated as the Interval Running Group (IR), Continuous Running Group (CR), or the Control Group.

Measurement

Measurements of the subjects' cardiorespiratory efficiency were taken prior to the start of the training program, at approximately the mid-point of the training program, and at the completion of the program. Oxygen consumption and pulse rate at rest and in recovery were used as criteria to determine cardiorespiratory efficiency.

Oxygen Consumption Test -- The subject prepared for the oxygen consumption test by mounting the treadmill and securing a nose clamp firmly in place. (Figure 1) The investigator then inserted a sterilized rubber mouthpiece into the subject's mouth to complete the closed respirometer circuit. A kymograph was connected to the respirometer to graphically record the amount of oxygen consumed from the closed respirometer circuit. To maintain normal breathing during the experiment, oxygen was introduced into the respirometer from a cylinder of medical oxygen resting under the respirometer.

The subject stood on the treadmill for four minutes breathing oxygen from the closed circuit respirometer, and graphically established a normal breathing pattern. At the end of 4 minutes each subject performed a standardized treadmill run at 10 miles per hour at an 8.6 percent grade for 1 minute and 30 seconds. Upon completion of the treadmill run the subject remained standing on the treadmill and the oxygen consumed in recovery from the standardized treadmill run was recorded by the kymograph. Oxygen

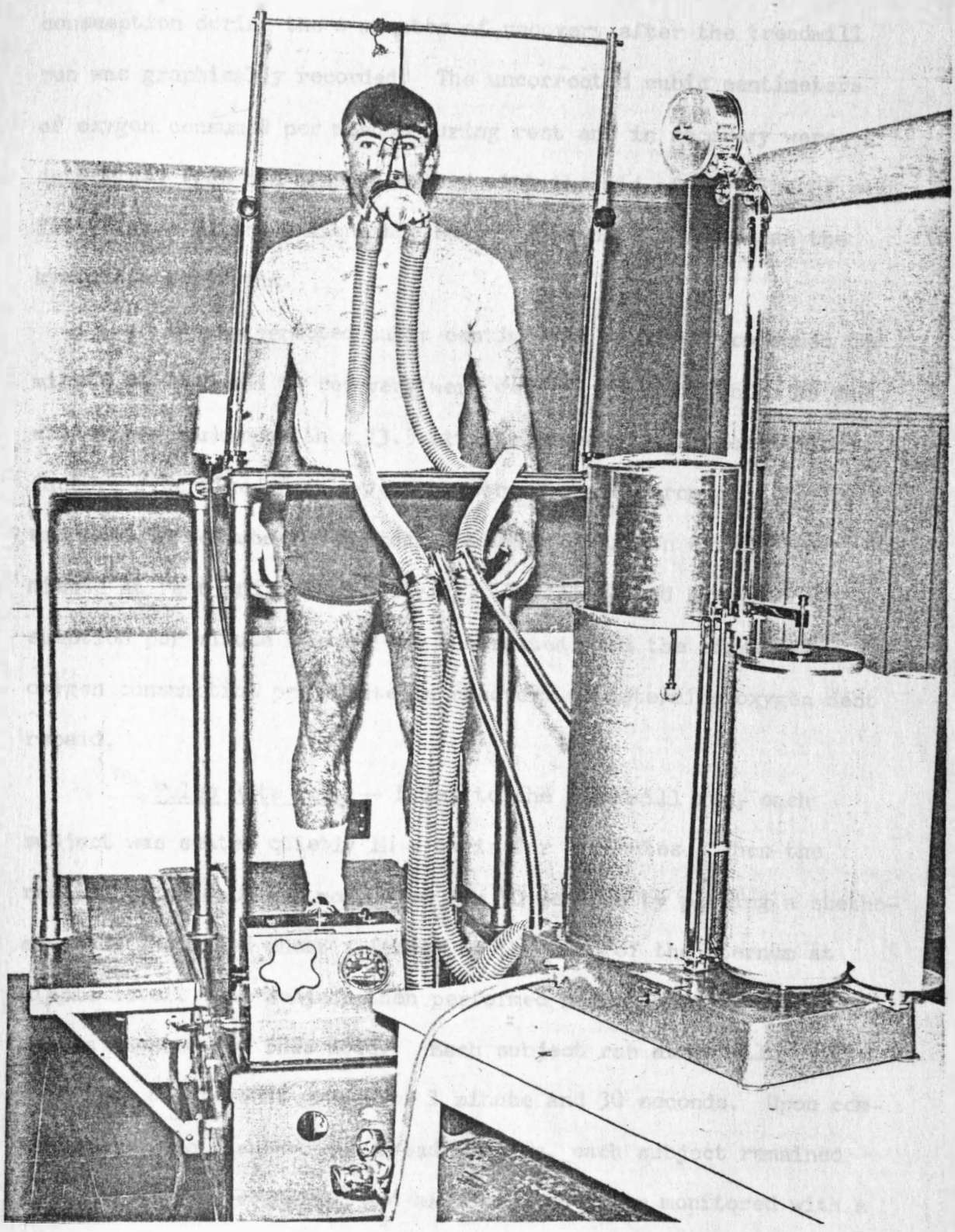

Figure 1. Closed Circuit Respirometer Connected to Subject

consumption during the 4 minutes of recovery after the treadmill run was graphically recorded. The uncorrected cubic centimeters of oxygen consumed per minute during rest and in recovery were determined from the graphic record with the aid of the line of best fit (Figure 2) drawn along the bottom tips of the spikes on the kymograph recording.

The uncorrected cubic centimeters of oxygen consumed per minute at rest and in recovery were determined and doubled as the writer was working with a 13.5 liter respirometer. A correction factor, determined from oxygen temperature and barometric pressure, was used to compute the corrected amount of oxygen consumed per minute at rest and during recovery. The corrected oxygen consumption per minute at rest was subtracted from the corrected oxygen consumption per minute in recovery to determine oxygen debt repaid.

Pulse Rate Test -- Prior to the treadmill run, each subject was seated quietly in a chair for 6 minutes. Then the resting pulse rate was monitored for 30 seconds by placing a stethoscope on the naked chest slightly to the left of the sternum at nipple level. The subject then performed the standardized treadmill run as adopted for this study. Each subject ran at 10 miles per hour up a 8.6 percent grade for 1 minute and 30 seconds. Upon completion of the standardized treadmill run, each subject remained standing on the treadmill, and his heart rate was monitored with a stethoscope for 30 seconds at the following intervals: 1 minute

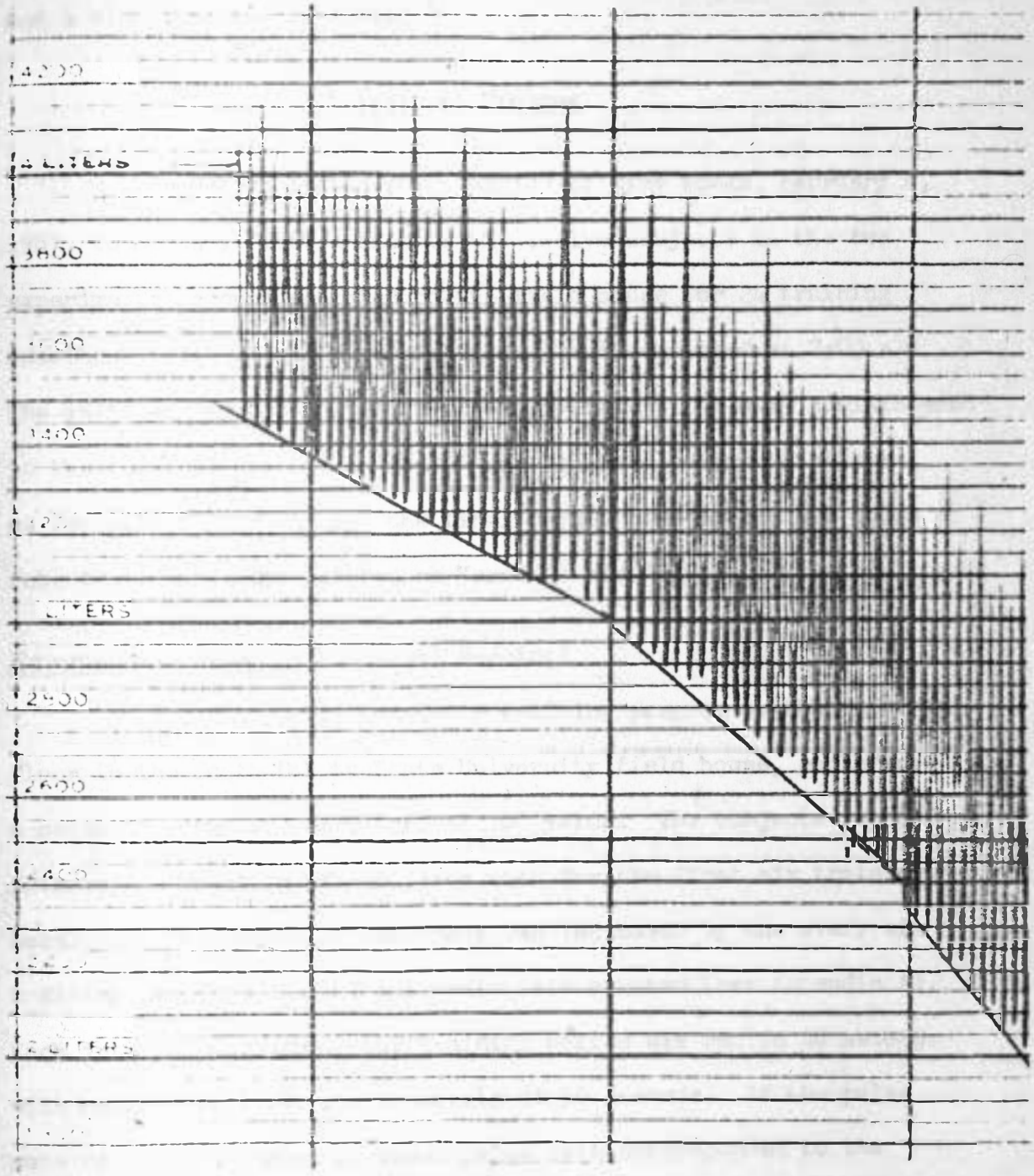

Figure 2. Line of Best Fit

after exercise, 2 minutes after exercise, 3 minutes after exercise, and 4 minutes after exercise.

Training Program

The study lasted for a period of five weeks, February 6, 1967, to March 9, 1967. Each of the twelve subjects in the two experimental groups reported to the field house for 24 training sessions. Each of the 24 training sessions commenced at 7:00 a.m. The initial oxygen consumption and pulse rate tests were administered to the three groups on January 20 and 21, the intermediate tests on February 23 and 24, and the final oxygen consumption and pulse rate tests were administered on March 13 and 14.

Experimental Group IR (Interval Running)

Group IR completed their training program on the main floor in the South Dakota State University field house, employing a measured unbanked board oval of 120 yards. The subjects ran 4 intervals consisting of 240 yards each for the first six training sessions. The number of intervals was increased by one every six training sessions until 7 intervals were reached (see Appendix A). Each interval throughout the training period was run in 40 seconds with maximum rest between intervals of 90 seconds. If the pulse rate of subject number 5, whose pulse rate corresponded to the pre-test mean resting pulse rate of the group, dropped to 120 beats per minute before the 90 second rest had elapsed, the group

immediately began the next running interval. Sprecher[12] explains this interval technique in Run, Run, Run, as the Gerschler-Reindel Law:

> After these 3000 experiments had been carried out for 21 days, it appeared that the heart did not at any time surpass 180 beats per minute in the course of physical exercise- 180 beats represent a limit.
>
> From this point (180 beats), the heart is permitted 1 minute, 30 seconds to return to 120 or 125 beats per minute; if it takes longer, it is because the effort demanded is (1) either too violent, or (2) too long.
>
> In the second case, the distance to be run should be shortened. One minute, 30 seconds also represents a limit. When the pulse has returned to 120-125 beats per minute, the runner is able to-and-ought to-begin running again, even if the heart took less than 1 minute, 30 seconds to recover.

Rest interval pulse rate was monitered in series of 10 seconds at the carotid artery by the palpation method.

Experimental Group CR (Continuous Running)

Group CR completed their running program in the wrestling room. The subjects of group CR ran continuously for 7 minutes for each of the first four training sessions and 9 minutes for each of the second four training sessions. The subjects' program was then increased to 11 minutes of continuous running for each of the next five training sessions and 13 minutes for each of the following five training sessions. Fifteen minutes of continuous running

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[12] P. Sprecher, "Visit With Dr. Woldemar Gerschler," Run, Run, Run, p. 150-151.

constituted each of the final six training sessions. (Appendix A) Group CR's only instructions were to run the required number of minutes in each training session. Group CR was not instructed to run at any set pace, but their running speed was checked with the use of a stop watch. The investigator directed the group to increase their pace when it was felt the pace was not sufficiently fast. This procedure was maintained to simulate the running programs employed by many wrestling coaches.

Control Group

The control group participated in the initial, intermediate and post tests, which consisted of oxygen consumption and pulse rate tests. The control group attended their regular physical education classes.

Chapter III

ANALYSIS OF DATA

Introduction

The assemblage of data,[13] (oxygen debt repaid during recovery, resting pulse rate, and pulse rate in recovery after exercise), collected at the beginning, intermediately, and at the end of the twenty-four session training program utilizing eighteen freshmen wrestlers at South Dakota State University is presented in the chapter.

[13] The data appears in the Appendixes B - G.

Scoring of Data

The uncorrected cubic centimeters of oxygen consumed per minute at rest and in recovery from a treadmill run were doubled as the writer was working with a 13.5 liter respirometer. A correction factor, based on barometric pressure and oxygen temperature, was employed to correct the amount of oxygen consumed by the subject to standard pressure and temperature.

The pulse rates were recorded for 30 seconds during rest and in recovery and required no conversion.

Reliability of Data

The investigator employed a standard procedure of checking the soda-lime crystals, the hoses and valves, the oxygen

pressure in the cylinder and the respirometer. No reliability coefficients were established for the oxygen consumption during the 4 minutes at rest or the 4 minutes in recovery from the treadmill run.

The pulse rate was monitored by placing a stethoscope on the naked chest slightly to the left of the sternum at nipple level. The pulse rates monitored by the investigator were checked against an E & M Physiograph on several occasions to insure accuracy. The pulse rate is variable and is affected by outside factors; therefore, no reliability coefficients were recorded for pulse rate during rest or in recovery.

Analysis of Data

The following measurements were taken: oxygen consumption, pulse rate at rest, and pulse rate during recovery for one minute, two minutes, three minutes, and four minutes after exercise. The analysis of data for this investigation dealt statistically with the mean gain or loss between the control group and two experimental groups. Statistical procedures were also applied to the mean gain or loss difference between the pretest, intermediate test, and post test within the control group and two experimental groups. The investigator employed the statistical procedures as suggested by Steel and Torrie[14] to determine the analysis of variance and

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[14]Robert G. D. Steel and James H. Torrie, Principles and Procedures of Statistics, p. 107-109.

Duncan's New Multiple-Range Test. The Duncan New Multiple-Range Test was applied when the F-ratio indicated or approached statistical significance. The .05 level of significance was chosen to denote statistically significant differences for the analysis of variance. A statistical coefficient at or beyond the .05 level necessitated a rejection of the null hypothesis. Fifteen degrees of freedom were used in all comparisons that did not involve the control group in the intermediate test with other groups or tests. Fourteen degrees of freedom were used when comparing the control group in the intermediate test with other groups or other tests. One subject in the control group was sick and missed the intermediate test, thus reducing the degrees of freedom from fifteen to fourteen. When Duncan's New Multiple-Range Test was employed, a protection level of .90 was present with alpha at the .05 level.

The F-ratio was computed for oxygen debt repaid, resting pulse rate, and pulse rate in recovery for 1 minute, 2 minutes, 3 minutes, and 4 minutes after exercise for the pretest; and no significance was found for this study.

Findings

Analysis of Variance (Between Groups)

Analysis of variance was applied between the control group and the two experimental groups to determine significance of difference for oxygen debt repaid, resting pulse rate, and pulse rate in recovery for 1 minute, 2 minutes, 3 minutes, and 4 minutes after

exercise. The following table (Table I) presents the statistical data concerning the difference of means on the pretest, intermediate test, and post test for all the test items.

Oxygen Consumption

The F-ratio was computed for the intermediate test and found to be .76 (Table 1). This was not statistically significant for this study.

The F-ratio was computed for the post test and found to be .02 (Table I). This was not statistically significant for this study.

Pulse Rate, Resting

The F-ratio was computed for the intermediate test and found to be .60 (Table I). This was not statistically significant for this study.

The F-ratio was computed for the post test and found to be 1.86 (Table I). This was not statistically significant for this study.

Pulse Rate, First Minute

The F-ratio was computed for the intermediate test and found to be 1.25 (Table I). This was not statistically significant for this study.

The F-ratio was computed for the post test and found to be .81 (Table I). This was not statistically significant for this study.

Table I

Summary of Analysis of Variance of Difference Between Group Means

of Pretest, Intermediate Test, and Post Test

Measurement	df	Variance among Means	Variance within Groups	F-ratio	Level of Significance
Oxygen Consumption (CC)					
Pretest	2/15	38.7	612,689.9	.00	NS
Intermediate test	2/14	479,255.9	629,472.8	.76	NS
Post test	2/15	10,316.6	433,934.7	.02	NS
Resting Pulse (30 sec.)					
Pretest	2/15	4.4	19.9	.22	NS
Intermediate test	2/14	8.1	13.4	.60	NS
Post test	2/15	26.0	14.0	1.86	NS
Pulse, 1st. min. (30 sec.)					
Pretest	2/15	32.7	24.8	1.32	NS
Intermediate test	2/14	103.5	83.0	1.25	NS
Post test	2/15	49.3	61.2	.81	NS
Pulse, 2nd. min. (30 sec.)					
Pretest	2/15	6.9	44.3	.16	NS
Intermediate test	2/14	74.6	59.0	1.26	NS
Post test	2/15	38.4	45.3	.85	NS

Table I (continued)

Measurement	df	Variance among Means	Variance within Groups	F-ratio	Level of Significance
Pulse, 3rd. min. (30 sec.)					
Pretest	2/15	4.5	22.3	.18	NS
Intermediate test	2/14	28.5	38.9	.73	NS
Post test	2/15	45.5	38.9	1.14	NS
Pulse, 4th. min. (30 sec.)					
Pretest	2/15	.7	24.7	.03	NS
Intermediate test	2/14	125.0	34.1	3.66	NS
Post test	2/15	57.2	39.7	1.44	NS

Pulse Rate, Second Minute

The F-ratio was computed for the intermediate test and found to be 1.26 (Table I). This was not statistically significant for this study.

The F-ratio was computed for the post test and found to be .85 (Table I). This was not statistically significant for this study.

Pulse Rate, Third Minute

The F-ratio was computed for the intermediate test and found to be .73 (Table I). This was not statistically significant for this study.

The F-ratio was computed for the post test and found to be 1.14 (Table I). This was not statistically significant for this study.

Pulse Rate, Fourth Minute

The F-ratio was computed for the intermediate test and found to be 3.66 (Table I). This was not statistically significant for this study.

The F-ratio was computed for the post test and found to be 1.44 (Table I). This was not statistically significant for this study.

Analysis of Variance (Within Groups)

Analysis of variance was applied within the control group and two experimental groups to determine significance of difference for oxygen debt repaid, resting pulse rate, and pulse rate in recovery for 1 minute, 2 minutes, 3 minutes, and 4 minutes after exercise. The following table (Table II) presents the statistical data concerning the difference of means on the pretest, intermediate test and post test on all of the test items.

The F-ratio was computed for the oxygen consumption, resting pulse rate, and pulse rate in recovery for 1 minute, 2 minutes, 3 minutes, and 4 minutes after exercise within the control group; and no significance was found for this study.

Oxygen Consumption

The F-ratio was computed for Group IR and found to be .17 (Table II). This was not statistically significant for this study.

The F-ratio was computed for Group CR and found to be .44 (Table II). This was not statistically significant for this study.

Pulse Rate, Resting

The F-ratio was computed for Group IR and found to be .04 (Table II). This was not statistically significant for this study.

Table II

Summary of Analysis of Variance of Difference Within Group Means

of Pretest, Intermediate Test, and Post Test

Measurement	df	Variance among Means	Variance within Groups	F-ratio	Level of Significance
Oxygen Consumption (CC					
Control	2/14	176,672.0	967,803.5	.18	NS
Group IR	2/15	71,066.1	419,022.3	.17	NS
Group CR	2/15	142,892.4	323,826.9	.44	NS
Resting Pulse (30 sec.)					
Control	2/14	36.4	24.0	1.52	NS
Group IR	2/15	3.5	95.4	.04	NS
Group CR	2/15	12.1	16.4	.13	NS
Pulse, 1st. min. (30 sec.)					
Control	2/14	45.5	33.7	1.35	NS
Group IR	2/15	108.4	41.9	2.59	NS
Group CR	2/15	273.4	90.3	3.03	NS
Pulse, 2nd. Min. (30 sec.)					
Control	2/14	66.0	40.0	1.65	NS
Group IR	2/15	210.2	47.9	4.39	.05
Group CR	2/15	210.7	60.1	3.51	NS

Table II (continued)

Measurement	df	Variance among Means	Variance within Groups	F-ratio	Level of Significance
Pulse, 3rd min. (30 sec.)					
Control	2/14	63.9	26.0	2.46	NS
Group IR	2/15	126.0	29.6	4.26	.05
Group CR	2/15	78.0	37.6	2.07	NS
Pulse, 4th. min. (30 sec.)					
Control	2/14	55.5	33.5	1.66	NS
Group IR	2/15	127.1	28.9	4.40	.05
Group CR	2/15	113.2	36.1	3.14	NS

The F-ratio was computed for Group CR and found to be .13 (Table II). This was not statistically significant for this study.

Pulse Rate, First Minute

The F-ratio was computed for Group IR and found to be 2.59 (Table II). This was not statistically significant for this study.

The F-ratio was computed for Group CR and found to be 3.03 (Table II). This was not statistically significant for this study.

Pulse Rate, Second Minute

The F-ratio was computed for Group IR and found to be 4.39 (Table II). This was statistically significant at the .05 level of significance.

The F-ratio was computed for Group CR and found to be 3.51 (Table II). This was not statistically significant for this study.

Pulse Rate, Third Minute

The F-ratio was computed for the interval running group and found to be 4.26 (Table II). This was statistically significant at the .05 level of significance.

The F-ratio was computed for the continuous running group and found to be 2.07 (Table II). This was not statistically significant for this study.

Pulse Rate, Fourth Minute

The F-ratio was computed for the interval running group and found to be 4.40 (Table II). This was statistically significant at the .05 level of significance.

The F-ratio was computed for the continuous running group and was found to be 3.14 (Table II). This was not statistically significant for this study.

Duncan's New Multiple-Range Test (Between Groups)

Duncan's New Multiple-Range Test was applied to the data that indicated or approached statistical significance by the analysis of variance. Because of the results of the application of the F-ratio (Table I) with no indication of approaching significant difference, data between the control group and two experimental groups, on oxygen consumption, resting pulse rate, and pulse rate in recovery for 1 minute, 2 minutes, 3 minutes, and 4 minutes were not treated statistically by use of Duncan's New Multiple-Range Test.

Duncan's New Multiple-Range Test (Within Groups)

Duncan's New Multiple-Range Test was applied to the data for Groups IR and CR concerning pulse rate in recovery for 1 minute, 2 minutes, 3 minutes, and 4 minutes. Because of the results of the application of the F-ratio (Table II) for Groups IR and CR with no indication of approaching significant difference, data on oxygen consumption and resting pulse rate were not treated statistically by the use of Duncan's New Multiple-Range Test.

Duncan's New Multiple-Range Test was applied to the data for the control group for pulse rate in recovery for the third minute. Because of the results of the application of the F-ratio for the control group with no indication of approaching significant differences, data on oxygen consumption, resting pulse rate, and pulse rate in recovery for 1 minute, 2 minutes, and 4 minutes were not treated statistically by the use of Duncan's New Multiple-Range Test.

Pulse Rate, First Minute

The Duncan New Multiple-Range Test was employed to compare the pretest to the intermediate test, pretest to the post test, and the intermediate test to the post test in Groups IR and CR. A score of 8.5 (Table III) was found between the pretest and intermediate test for Group IR. This was significant beyond the .05 protection level. A score of 13.2 (Table III) was found between the pretest and intermediate test for Group CR. This was significant beyond the .05 protection level. For this investigation no other significance was found for recovery for the first minute within groups.

Pulse Rate, Second Minute

The Duncan New Multiple-Range Test was employed to compare the pretest to the intermediate test, pretest to the post test, and the intermediate test to the post test in Groups IR and CR. A score of 11.8 (Table IV) was found between the pretest and

Table III

Summary of Duncan's New Multiple-Range Test Within Groups for Recovery Pulse Rate for the First Minute

Pulse Rate, First Minute			
	Group IR		
Rank	1	2	3
Mean	59.5	63.7	68
Group	Intermediate test	Post test	Pretest
	Group CR		
Rank	1	2	3
Mean	58.5	67.7	71.7
Group	Intermediate test	Post test	Pretest

Any two means not underscored by the same line are significantly different.
Any two means underscored by the same line are not significantly different.
Protection level is .90 at .05 level. (Alpha error .05 when 3 groups compared)

Table IV

Summary of Duncan's New Multiple-Range Test Within Groups for Recovery Pulse Rate for the Second Minute

Pulse Rate, Second Minute			
	Group IR		
Rank	1	2	3
Mean	50.7	56.8	62.5
Group	Intermediate test	Post test	Pretest
	Group CR		
Rank	1	2	3
Mean	53.2	61.8	64.5
Group	Intermediate test	Post test	Pretest

Any two means not underscored by the same line are significantly different.
Any two means underscored by the same line are not significantly different.
Protection level is .90 at .05 level. (Alpha error .05 when 3 groups compared)

intermediate test for Group IR. This was significant beyond the .05 protection level. A score of 11.3 (Table IV) was found between the pretest and intermediate test for Group CR. This was significant beyond the .05 protection level. For this investigation no other significance was found for the second minute pulse rate in recovery.

Pulse Rate, Third Minute

The Duncan New Multiple-Range Test was employed to compare the pretest to the intermediate test, pretest to the post test, and the intermediate test to the post test in the Control Group and Groups IR and CR. For the Control Group no significance was found (Table V). A score of 9.0 (Table V) was found between the pretest and intermediate test for Group IR. This was significant beyond the .05 protection level. For Group CR no significance was found (Table V). For this investigation no other significance was found for pulse rate in recovery for the third minute within groups.

Pulse Rate, Fourth Minute

The Duncan New Multiple-Range Test was employed to compare the pretest to the intermediate test, pretest to the post test, and the intermediate test to the post test in Groups IR and CR. A score of 9.0 (Table VI) was found between the pretest and intermediate test for Group IR. This was significant beyond the .05 protection level. A score of 7.8 (Table VI) was found between the pretest and intermediate test for Group CR. This was significant

Table V

Summary of Duncan's New Multiple-Range Test Within Groups for Recovery Pulse Rate for the Third Minute

Pulse Rate, Third Minute			
	Control Group		
Rank	1	2	3
Mean	53.8	55.2	60.2
Group	Intermediate test	Post test	Pretest
	Group IR		
Rank	1	2	3
Mean	49.7	52.7	58.7
Group	Intermediate test	Post test	Pretest
	Group CR		
Rank	1	2	3
Mean	53.7	58.7	60.7
Group	Intermediate test	Post test	Pretest

Any two means not underscored by the same line are significantly different.
Any two means underscored by the same line are not significantly different.
Protection level is .90 at .05 level. (Alpha error .05 when 3 groups compared)

Table VI

Summary of Duncan's New Multiple-Range Test Within Groups for Recovery Pulse Rate for the Fourth Minute

Pulse Rate, Fourth Minute			
Group IR			
Rank	1	2	3
Mean	47.8	50.7	56.8
Group	Intermediate test	Post test	Pretest
Group CR			
Rank	1	2	3
Mean	49.7	56.8	57.5
Group	Intermediate test	Post test	Pretest

Any two means not underscored by the same line are significantly different.
Any two means underscored by the same line are not significantly different.
Protection level is .90 at .05 level. (Alpha error .05 when 3 groups compared)

beyond the .05 protection level. For this investigation no other significance was found for the pulse rate in recovery for the fourth minute.

Summary of Findings

Statistically significant improvement was noted within Group IR between the pretest and intermediate test on pulse rate in recovery for 1 minute, 2 minutes, 3 minutes, and 4 minutes as determined by the use of the analysis of variance and Duncan's New Multiple-Range Test.

Statistically significant improvement was noted within Group CR between the pretest and intermediate test on pulse rate in recovery for 1 minute, 2 minutes, and 4 minutes as determined by the use of the analysis of variance and Duncan's New Multiple-Range Test.

Discussion of Findings

No statistically significant difference was found between the three groups, consisting of the control, experimental group IR, and the experimental group CR on any of the test items. Since a running program does not increase cardiorespiratory efficiency, the investigator assumes the main contribution of such a program is psychological.

The investigator suggests that if a coach employs a running program as a supplement to wrestling practice, the running

program should be planned for the psychological aspects to convince the team of the running program's beneficial effects on stamina and endurance in the latter stages of a wrestling match and in tournament situations.

In the writer's opinion, neither of the experimental training programs, involving Group IR and Group CR, appeared to be a more effective method of increasing cardiorespiratory efficiency. Groups IR and CR both showed a statistically significant difference within the groups between the pretest and intermediate test on recovery pulse rate items. Both groups regressed between the intermediate test and post test. In the investigator's opinion, this regression could have been due to a lack of motivation in wrestling practice, since the dual meet season ended for the freshman squad, February 22, 1967, while wrestling practice and running programs continued until March 9, 1967. The control group also regressed from the intermediate test to the post test in the third minute of pulse rate recovery. This regression in the control group seems to substantiate the investigator's opinion.

Chapter IV

SUMMARY

Problem

The purpose of this study was to determine whether a running program significantly influences the cardiorespiratory efficiency of conditioned wrestlers and to compare continuous running and interval running as methods of increasing the cardiorespiratory efficiency of conditioned wrestlers.

Data

Subjects that participated in this investigation were members of the freshman wrestling squad at South Dakota State University during the spring semester, 1967. Eighteen of the 19 members of the freshman squad volunteered to be subjects for the investigation. A five-week running program, 24 sessions in length, was administered to the two experimental groups, each composed of six subjects. The control group was composed of six subjects. The interval running experimental group increased its running from 4 intervals to 7 intervals per training session during the course of the training program. Each interval consisted of 240 yards which was run in 40 seconds with an unknown rest which was determined by pulse rate and lasted a maximum of one minute and thirty seconds. The continuous running experimental group increased its running

from 7 minutes to 15 minutes each training session during the course of the training session.

Measurements of the subjects' cardiorespiratory efficiency were taken prior to the start of the training program, at approximately the mid-point of the training program, and at the completion of the program. Oxygen consumption and pulse rate at rest and in recovery were used as criteria for cardiorespiratory efficiency.

Data obtained during testing were recorded and analyzed by employing analysis of variance (F-ratio) and Duncan's New Multiple-Range Test.

Findings

1. No statistically significant difference was found between the control group and Group IR, the control group and Group CR, or between Group IR and Group CR.

2. Group IR made statistically significant improvement within the group between the pretest and intermediate test for pulse rate in recovery for 1 minute, 2 minutes, 3 minutes, and 4 minutes after exercise.

3. No statistically significant difference was found for Group IR within the group for oxygen consumption and resting pulse rate.

4. Group GR made statistically significant improvement within the group between the pretest and intermediate test for pulse rate in recovery for 1 minute, 2 minutes, and 4 minutes after exercise.

5. No statistically significant difference was found for group CR within the group for oxygen consumption, resting pulse rate, and pulse rate in recovery for the third minute.

Conclusions

From the findings of this investigation the following conclusions were drawn: that a running program in addition to wrestling practice does not appear to increase significantly the cardio-respiratory efficiency of a conditioned wrestling squad, and that the benefits of a running program to supplement wrestling practice may be largely psychological.

Recommendations for Further Study

Based on the information obtained in this investigation, the investigator would make the following recommendation for further study:

1. That a similar study be conducted with a more strenuous running program for both of the experimental groups.

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APPENDIXES

Appendix A

INTERVAL AND CONTINUOUS TRAINING PROGRAMS

Interval Training Program

Interval runs of 240 yards in 40 seconds with a maximum resting interval of 1 minute and 30 seconds between runs.

Sessions One To Six	4 intervals per session
Sessions Seven To Twelve	5 intervals per session
Sessions Thirteen To Eighteen	6 intervals per session
Sessions Nineteen to Twenty-four	7 intervals per session

Continuous Running Training Program

Continuous running without any set pace for the required number of minutes.

Sessions One to Four	7 minutes per session
Sessions Five to Eight	9 minutes per session
Sessions Nine to Thirteen	11 minutes per session
Sessions Fifteen to Eighteen	13 minutes per session
Sessions Nineteen to Twenty-four	15 minutes per session

Appendix B

RAW DATA: OXYGEN CONSUMPTION PRETEST, INTERMEDIATE TEST, AND POST TEST (CC)

Subject	Pretest	Intermediate test	Post test
	CONTROL GROUP		
1	4738.5	2939.4	2970.5
2	4081.7	3195.8	3364.0
3	3581.6	4576.0	3502.0
4	3389.9	------	3385.2
5	3204.0	3380.0	5200.0
6	1565.6	1765.1	2716.8
	GROUP IR		
1	4284.8	2746.3	3241.4
2	3803.7	2941.0	3831.5
3	3389.9	5342.4	3295.5
4	3422.8	3582.6	3684.6
5	2883.6	3582.6	3676.3
6	2801.6	3625.3	3844.8
	GROUP CR		
1	4367.2	3702.4	4035.2
2	4030.0	3573.2	4054.6
3	3116.0	4175.9	2957.5
4	3284.1	3244.8	2408.3
5	2956.5	4054.6	3718.0
6	2835.0	3646.4	3974.4

Appendix C

RAW DATA: RESTING PULSE RATE FOR PRETEST, INTERMEDIATE TEST, AND POST TEST (30 SEC.)

Subject	Pretest	Intermediate test	Post test
	CONTROL GROUP		
1	30	29	31
2	36	34	37
3	41	35	26
4	42	--	35
5	38	37	40
6	33	34	29
	GROUP IR		
1	31	36	37
2	31	33	31
3	36	31	33
4	37	33	33
5	35	32	33
6	40	36	37
	GROUP CR		
1	34	31	36
2	32	36	31
3	41	35	41
4	29	29	32
5	35	34	45
6	42	40	37

Appendix D

RAW DATA: PULSE RATE IN RECOVERY FOR FIRST MINUTE FOR PRETEST, INTERMEDIATE TEST, AND POST TEST (30 SEC.)

Subject	Pretest	Intermediate test	Post test
	CONTROL GROUP		
1	73	61	70
2	78	76	81
3	75	66	65
4	76	--	64
5	67	63	70
6	65	67	65
	GROUP IR		
1	67	58	65
2	63	58	59
3	67	58	59
4	77	69	77
5	69	66	62
6	65	48	60
	GROUP CR		
1	67	55	62
2	70	68	68
3	79	73	79
4	67	38	52
5	71	55	69
6	76	62	76

Appendix E

RAW DATA: PULSE RATE IN RECOVERY FOR SECOND MINUTE FOR PRETEST, INTERMEDIATE TEST, AND POST TEST (30 SEC.)

Subject	Pretest	Intermediate test	Post test
	CONTROL GROUP		
1	67	56	54
2	70	67	70
3	63	54	52
4	66	--	59
5	51	56	62
6	68	57	55
	GROUP IR		
1	58	48	58
2	57	45	50
3	60	56	55
4	77	55	69
5	61	58	52
6	62	42	57
	GROUP CR		
1	60	49	60
2	68	62	62
3	71	65	70
4	56	37	50
5	64	51	62
6	68	55	67

Appendix F

RAW DATA: PULSE RATE IN RECOVERY FOR THIRD MINUTE FOR PRETEST, INTERMEDIATE TEST, AND POST TEST (30 SEC.)

Subject	Pretest	Intermediate test	Post test
	CONTROL GROUP		
1	61	53	57
2	67	62	62
3	56	48	47
4	63	—	56
5	59	54	59
6	55	52	50
	GROUP IR		
1	54	49	56
2	54	41	44
3	59	53	51
4	69	50	62
5	57	54	47
6	59	51	56
	GROUP CR		
1	57	47	56
2	62	60	58
3	64	49	65
4	54	41	49
5	60	51	59
6	64	61	62

Appendix G

RAW DATA: PULSE RATE IN RECOVERY FOR FOURTH MINUTE FOR PRETEST, INTERMEDIATE TEST, AND POST TEST (30 SEC.)

Subject	Pretest	Intermediate test	Post test
	CONTROL GROUP		
1	59	52	56
2	63	60	63
3	51	43	45
4	60	--	54
5	57	49	58
6	53	50	48
	GROUP IR		
1	53	48	54
2	52	41	40
3	58	52	50
4	65	46	60
5	55	50	46
6	58	50	54
	GROUP CR		
1	55	42	54
2	59	58	56
3	63	56	64
4	48	41	49
5	57	49	58
6	63	52	60